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THE GEOLOGICAL RELATIONS OF THE PRINCIPAL NOVA SCOTIA MINERALS.

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ANY estimate of the economic mineral value of an unvisited district is to the mining engineer largely a comparative one. If he knows that certain minerals characterize any given geological horizon he naturally draws upon his experience of the same ores as met by him under similar geological conditions. And if he has not had the personal experience, the investigation of the geology of a similar district as given in a trustworthy report enables him to lay a fair basis for conclusions.

In a general way these conclusions are of value, and while they pronounce on the possible mineral fecundity of a given district, they often give a decided rebuttal to startling statements of discoveries of ores.

The number of the geological horizons in Nova Scotia is limited, but they are well developed, in some case typically, and exert a prominent effect on the agricultural and industrial distribution of its inhabitants.

The following table, based on Sir William Dawson's *Acadian Geology*, will serve as an outline for my notes :

Modern.	
Triassic sandstone and trap.	
Permo Carboniferous.	
Carboniferous	{ Upper coal measures.
	{ Productive coal measures.
	{ Millstone grit.
	{ Marine limestone.
Devonian	{ Lower Carboniferous.
	{ Upper Helderberg.
	{ Oriskany.
Upper Silurian	{ Lower Helderberg.
	{ Clinton.
Lower Silurian.	
Cambro-Silurian.	
Cambrian, Longmynd series.	
Laurentian.	

This list is intended to refer rather to the divisions known to contain ores, than to be a complete geological scale of the province.

Geographically speaking, in Nova Scotia proper these divisions are represented as follows: On the Atlantic coast are the Cambrian of the gold-fields with their associated granites. Then follow the measures of the Cobequids running through Cumberland, Pictou, Colchester and Antigonishe counties, supporting Silurian and Devonian strata, the latter being met also in the western part of the province. The Carboniferous occupies the Gulf shore, and much of the district surrounding the Basin of Minas. The Triassic measures are met in narrow fringes and outliers around the Bay of Fundy. In Cape Breton the northern part of the island is largely composed of Laurentian, which occurs also between the arms of the Bras d'Or Lake. The Carboniferous rests on it, and forms fringes, while it is replaced in Richmond County by several large areas of Devonian.

Taking the divisions in descending order, their best known minerals are:

Modern.—Beds of bog iron-ore, manganese wad, peat, infusorial earth and clays are frequently met. A number of years ago the iron-ore was smelted in connection with older ores, at Clementsfort near Annapolis. Deposits of considerable extent have been observed in Shelburne, Queens, Kings, and Pictou counties, and no doubt exist at many other localities. The wads are met in Cape Breton at several points, in deposits of considerable size, yielding from 20 to 40 per cent. of ore with water, iron, silicious matter, etc. Smaller deposits are not unfrequently found, but as there is no demand they are not sought after. The deposits of infusorial earth have been used locally for insulating steam-pipes, and as an absorbent in the manufacture of dynamite.

Triassic.—The trap and associated ash-beds yield numerous varieties of zeolitic and other minerals. At several points they are penetrated by veins of massive and crystalline magnetite and specular ore of remarkable purity. The thickest vein that has come under the writer's notice, of magnetite, was about 15 inches wide.

At numerous points, most noticeably at Margaretville, copper-ores, principally carbonates with native copper, are found in veins in the trap and ash. These veins have been explored several times without success. No records have been made of the "low-grade" values of these rocks, and I believe from the frequent occurrence of copper-ores over so wide an extent of territory that locally, beds may be found carrying the disseminated metal in amounts of econo-

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mic value. The associated sandstones, red and friable, yield no building stone of value, and as yet have furnished to the miner only a few tons of manganiferous ochre.

Permo-Carboniferous.—In the great mass of sediments covering large areas in Pictou, Colchester, and Cumberland counties, and presenting fossil evidence of a transition from the Carboniferous to the Permian, there are few minerals of economic value. A few thin seams of coal are met, with fire-clays. At numerous points the sandstones and shales present irregular bedded masses and layers of copper-ores, principally gray sulphurets, with films and coatings of carbonate. These ores are associated with fossil plants to whose presence their deposition is to be attributed. Hitherto, attempts to find these ores in workable amounts have not been successful. A sample from Carribou, near Pictou, gave :*

	Per cent.
Copper, ...	40.00
Iron, ...	11.06
Cobalt, ...	2.10
Manganese, ...	0.50
Sulphur, ...	25.42
Lime, ...	0.92

Admirable varieties of building stone, variously tinted sandstones and free stones have been quarried from these measures.

Upper Coal Measures.—These strata in general resemble those noticed in the preceding section. There is however more coal ; and layers of clay iron-stone are frequently met.

Productive or Middle Coal Measures.—The principal mineral of this formation is coal, which is worked in Cape Breton, Pictou, and Cumberland counties. Deposits are known in five other counties, but have not been worked to any extent. The production last year was about 1,700,000 tons. The coal is bituminous, and the writer is not aware of the occurrence of any hard coal, although several discoveries of graphitic shale have been heralded as anthracite mines. Speaking in general terms the Cape Breton coal is the most bituminous, that of Cumberland less so, while the Pictou coals rather approach the semi-bituminous or steam variety. All the districts furnish coke of fair quality.

The following average of an analyses, from a paper on Canadian coals, read before the Montreal meeting of the British Association, will serve to show the variation in quality :

* *Acadian Geology.*

	Cape Breton.	Pictou.	Cumberland.
Moisture, ...	0.75	1.19	1.46
Vol. combustible matter, ...	37.26	29.10	33.69
Fixed carbon, ...	58.74	60.63	59.35
Ash, ...	3.25	9.34	5.50

The fire-clays accompanying these coals have never been systematically tested as to their value for fire-brick. Some that have come under my notice are too high in alkali and iron, while others theoretically were of satisfactory composition. An investigation into the capabilities of the fire-clays of Nova Scotia would form an object worthy the attention of the Canadian Geological Survey. Beds of cannel and oil coal, and of bituminous shale, are frequently met, but are not at present of economic value.

Beds of clay iron-stone (in a few instances of the black band variety) up to a thickness of 12 inches are numerous. The following analyses made by me are of samples from the Pictou coal-field.

	Clay Iron-stone.	Black Band.
Moisture, ...	2.132	0.732
Iron protoxide, ...	45.361	36.000
Alumina, ...	16.962	3.180
Silicious residue, ...	0.780	16.546
Lime, ...	trace.	3.780
Magnesia, ...	1.655	0.783
Manganese, ...	trace.	4.450
Sulphur, ...	0.612	0.214
Phosphoric acid, ...	trace.	.586
Carbonaceous matter, ...	—	6.140
Carbonic acid, ...	—	27.589
Metallic iron, ...	35.00	28.000

Millstone Grit.—The dividing line “between the millstone grit and productive measures is not a fixed one, and consequently there are workable beds of coal in its upper part arbitrarily referred to this horizon, but practically belonging to the productive measures. Throughout this range of measures thin seams of coal occur at numerous points, but in the presence of the larger and better known beds they have not yet received attention. At the Joggins, Cumberland County, large quantities of excellent grindstones are made for local use, and for export, and numerous beds of quarry rock are known.

Marine Limestone.—This horizon is very strongly developed in Nova Scotia, and to its presence is due the fertility of the central and northern part of the province, for its gypsum, limestone, and marl

yield soils of permanent fertility. Its most prominent mineral is gypsum, in every variety and texture, which occurs in beds in many cases extending for miles, and reaching in thickness 100 feet. It is quarried for export to the United States, chiefly near Windsor, in the basin of Minas, the annual production varying from 100,000 to 150,000 tons. A few thousand tons are annually sent up the Gulf of St. Lawrence from Cape Breton, but the export trade, on account of the difference in freight, is from the Windsor district. Limestone is equally abundant, and is burned for local use, and used in rough masonry, and at Walton, near Windsor, furnishes a beautiful red stone, which it is said will first be used in the new buildings of a prominent New York newspaper. At several points these limestones carry deposits of manganese, lead, iron, and copper-ores and barytes. The manganese is met as pyrolusite with a little hard ore, and is of remarkable purity, carrying very minute amounts of iron. It brings a price varying up to \$100 a ton, but the demand is limited. I am not aware of any deposits of these ores adapted to the steel-makers' purposes. Tenny Cape, Onslow, and Loch Lomond are the best known mines.

The iron-ores are limonite, red hematite, and spathic ore. As yet the ores of this series are little worked, but they are of undoubted value. The purity of some of them may be shown by the following analysis of a sample from Brookfield:

	Per cent.
Water, ...	11.36
Silica, ...	1.54
Sulphuric acid, ...	trace.
Phosphoric acid, ...	trace.
Metallic iron, ...	60.00

The spathic ore occurs in beds, the limonite and red hematites as contact and replacement deposits. The lead-ores occur as small segregated veins, and as aggregates. The silver contents of the Nova Scotia lead-ores are variable, assays have returned as high as 100 ounces, but the average would not exceed 10 ounces. The copper-ores resemble in composition and mode of occurrence those already described. Celestine, fluorspar, and brine and mineral springs also occur in these measures.

Devonian (Upper Helderberg, Oriskany).—In the hills lying to the south of the Annapolis valley are numerous important bedded deposits of magnetite and hematite. The ores vary in character, but some are of excellent quality and favorably situated for mining and

exportation. In Guysboro' County the Devonian measures carry several large deposits of specular ore of good quality, but as yet unproven. The ore is presented in veins and in large masses, and may be connected with the dioritic dykes found at this point. It occurs under similar conditions near St. Peters. I believe that by some the copper-ores of Polsons Lake and Lochaber in Antigonishe County are referred to this horizon. These deposits are connected with igneous dykes, and, as far as they have been explored, appear very promising, but their distance from shipping, etc., has diverted attention from them.

Upper Silurian (Lower Helderberg, Clinton).—In Pictou and Antigonishe counties, strata which are referred to this age carry important deposits of bedded red hematites, varying in thickness up to 50 feet. The ores are silicious, but frequently free from sulphur and phosphorus; their metallic contents vary from 35 to 50 per cent. Owing to their size and accessibility they can be cheaply mined, and will probably be utilized in connection with the richer ores found in their vicinity.

Lower Silurian.—These measures as developed in Cape Breton carry several beds of red hematite, and deposits of copper pyrites and sometimes cuprififerous iron pyrites.

Cambro-Silurian.—This term has been provisionally applied to the mass of strata forming the Cobequid hills and reappearing in Pictou County. The ores occurring in these measures embrace several varieties of hydrated and anhydrous peroxide. At Londonderry the limonite occurs with a little specular in a large interstratified vein containing ankerite and sideroplesite, the latter being used to some extent in the furnaces of the company operating at this point. Magnetites have also been met in parts of this range. In Pictou County the ores occur in interstratified veins with ankerite, but are principally specular. Copper- and gold-ores are reported as occurring in this range, but I am uninformed concerning their economic value. The deposits of antimony-ore at Rawdon, Hants County, have been worked for several years, and are probably extensive. Their exact geological horizon is not yet clearly known, but they are referred to here.

Cambrian (Longmynd).—The only mineral of economic value yet found in these measures is gold. The strata are slate and quartzite lying in large abrupt folds, which have permitted the intercalation of the gold-bearing quartz-veins, varying in thickness up to 12 feet. The gold is also found disseminated in some of the beds of slate.

Copper, lead, zinc, iron, and molybdenum sulphides occur with the gold in the quartz-veins, but not in amounts of economic value. The auriferous territory is estimated to cover 3000 square miles, and as the annual production of gold is only about 23,000 ounces, there is an ample opening for miners.

Laurentian.—This series is widely distributed in Cape Breton, and roughly speaking is divisible into the felsite and the limestone series. They contain red hematite, in places magnetic, of excellent quality, although some are reported to be rather high in phosphorus for Bessemer purposes. Copper-ores, graphite, asbestos and mica are also found. The limestones are frequently altered into marbles. Some of the deposts are beautifully tinted, and are said to be adapted for building and statuary purposes. At present the West Bay (Cape Breton) marble is largely burned into a lime of excellent quality, which is used in the province, and exported to the United States, etc. To complete the parallel between these Cape Breton strata and the Laurentian rocks of the vicinity of Ottawa, there remains to be discovered in the former "Phosphate Rock," and there appears to be no reason for its absence.

Copper ores are found at numerous points and are undoubtedly valuable as they are widespread and at the surface show well, but up to this date no decided steps for development have been made except in the case of the copper-ores of Coxheath, near Sydney. Here the Eastern Development Company have proved several large veins carrying copper in workable amounts to a depth of 300 feet. The ore is calcopyrite with erubescite, and carries considerable amounts of gold and silver. Molybdenite also occurs in small disseminated grains and nodules at several points, and a few lots have been shipped to England.

In summing up these brief notes it may be said that the visitor to the province would place the minerals, irrespective of any development effected, in the following order: Coal, Iron, Gold. It is perhaps unusual to find these three so close together.